Global Effects of Smoking, of Quitting, and of Taxing Tobacco

Prabhat Jha
prabhat.jha@utoronto.ca
Twitter: @Countthedead

Centre for Global Health Research, St. Michael’s Hospital
Dalla Lana School of Public Health, University of Toronto
CONCLUSIONS:

• On current patterns: 1 Billion smoking deaths this century, including about 250 million deaths among those <35 years in just 16 countries

• Prolonged smokers lose about one decade of life

• Cessation by age 40 (and preferably earlier) avoids 90% of the excess risk of continued smoking

• WHO goal of 30% reduction in smoking can be achieved by tripling the excise tax worldwide

• Mortality monitoring is needed: various strategies possible at low cost, high-impact

Source: Jha and Peto, NEJM, 2014
CONCLUSIONS:
Monitoring the tobacco epidemic

- Prospective studies, with good control for prolonged smoking, and reverse causality ("cancer cures smoking")
- Retrospective case control studies using living controls (e.g. India Million Death Study)
- Retrospective proportional mortality using non-tobacco attributable deaths (China, South Africa, Bangladesh): Smoking on death certificates
- Indirect methods-Peto method indexing on lung cancer
A billion tobacco deaths in the 21st century on current smoking patterns

Global sales ~6,000 B sticks (vs 5,000 B in 1990)

1 ton of tobacco=1 M sticks=1 death
Males, England & Wales, % survival at period rates

Source: Gary Whitlock, CTSU from Registrar-General reports and Human Mortality Database
* Males and females combined- from Edmond Halley, 1693 for Breslaw, Germany
Global survival to age 70 years

- at 1970 rates: 40% male, 50% female
- at 2010 rates: 60% male, 70% female
- at 2030 rates: 75% male, 80% female?

(proposed “Sustainable development goal” of 40% cut in death rates in 2030 vs 2010)

Source: Norheim, Jha, Addis et al, Lancet 2014
Figure 2: 40-year trends, 1970-2010, in risks of dying in selected age ranges for World (left) and 4 World Bank groups of countries (low to high income).

Source: Norheim, Jha, Addis et al, Lancet 2014
Worldwide no of substance users
B=billions, M=millions

<table>
<thead>
<tr>
<th>Substance</th>
<th>Users</th>
<th>Annual deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>1.3 B *</td>
<td>~ 5 M</td>
</tr>
<tr>
<td>Drinking</td>
<td>2.0 B</td>
<td>~ 2 M</td>
</tr>
<tr>
<td>Substance Illicit drugs</td>
<td>0.2 B</td>
<td>~ 0.2 M</td>
</tr>
</tbody>
</table>

Users
1 ton of tobacco = 1 M sticks = 1 death

Source: WHO 2002
• Risk of addiction is greater for smoking
• Risk of addiction is greater for smoking

• No “learning” from youthful excesses
  • Risk of death from smoking is much higher: of 1000 males smokers aged 20
    • 250 die from smoking in middle-age
      • 20 die from road accidents or violence (30

Source: Jha et al., 2000
World annual tobacco deaths

Developed countries ~2M
World annual tobacco deaths

Developed countries ~2M
China ~1M
India ~1M
UK, US, Canada, India & China: smoking causes far more deaths than drinking does
UK, US, Canada, India & China: smoking causes far more
2010: Russian president Dmitry Medvedev spearheads new offensive against vodka, blamed for 500,000 deaths a year.

Sensationalist adverts, steep price rises and bombastic rhetoric pull out all the stops.

[guardian.co.uk](http://guardian.co.uk)  Monday 21 June 2010

Ice fishermen sip vodka at a lake in Moscow.
All-cause mortality, males aged 15–54, in Russia and UK 1980–2007

Russian mortality rates show a significant increase from the late 1980s to the early 1990s, with a peak in the late 1990s. This is followed by a decrease in the early 2000s. Key events include:

- USSR restricts alcohol mid-1985; use decreases by around 25%.
- USSR collapses late in 1991.
- Rouble collapses late in 1998.

Russian mortality rates peak around 2000 and then decrease, reflecting economic stabilization and policy changes. In contrast, UK mortality rates remain relatively stable throughout the period.

* Mean of rates in component 5-year age groups (15–19 to 50–54 years)

Source: WHO mortality & UN population estimates

Source: Lancet
27 June 2009
Russian male death rate ratios

~1 bottle of vodka/day
vs <0.5 bottles/week:

2 x any medical cause
4 x road traffic accident
6 x any other accident
8 x suicide
10 x murder

Source: Lancet 27 June 2009
MALE under-50 mortality 1970-2010: 6 countries

Source: Norheim, Jha, Addis et al, Lancet 2014
FEMALE under-50 mortality 1970-2010: 6 countries

Source: Norheim, Jha, Addis et al, Lancet 2014
Life expectancy loss of 3 years with moderate obesity and 10 years with smoking

2 kg/m² extra BMI (if overweight) or 10% smoking prevalence shortens life by ~1 yr

Source: Peto, Whitlock, Jha, NEJM, 2010
Tobacco’s Shifting Burden: From the Rich to the Poor

More and more people in developing countries are taking up smoking, while people in developed nations are giving up the habit. This means tobacco-related deaths are shifting to low- and middle-income countries.

Where do most of the world’s smokers live?

GLOBAL TOBACCO-RELATED DEATHS

20th Century

- 70% High-income countries
- 30% Low- and middle-income countries

100 MILLION

21st Century

- 30% High-income countries
- 70% Low- and middle-income countries

1 BILLION (projected)

50%

More than 50% of all smokers live in just five low- and middle-income countries.*

* Brazil, China, India, Indonesia, Russia

Sources: R. Peto (Oxford Univ.), CGHR, WHO 2009

Find out more at theworld.org/cancer
- 30 years between peak smoking and peak lung cancer

US adults

US lung cancer (men)

China (men)

Indonesia (men)

Year
Sir Richard Peto and the late Sir Richard Doll (1912-2005), in Oxford

Never smoked regularly

Continuing cigarette smokers since 1951

% survival from age 35

Age

0 10 20 30 40 50 60 70 80 90 100

97 94 91 81 59 26 24 4 2
Effect of stopping smoking at age ~40 on survival from age 40

--- stopped age 35–44

% survival from age 40

Continuing cigarette smokers

Never smoked regularly

Age

Fig. 3b
19-APR-2004 15:02:06
Survey US women and men & link them to the National Death Index “Facebook of death”

(Hazard ratios* current vs. never smokers, ages 25-79, by gender)

WOMEN WHO SMOKE: 3.0 times more likely to die
MEN WHO SMOKE: 2.8 times more likely to die

Source: Jha et al, NEJM, Jan 24, 2013
Cessation more common in men than in women

At ages 65 to 69, ratio of former to current smokers is 2:1 for women but 4:1 for men

Source: Jha et al, NEJM, Jan 24, 2013
## Hazard ratios* by disease for current vs. never smokers, United States 1997-2006, ages 25-79, by gender

<table>
<thead>
<tr>
<th>Disease</th>
<th>Women (Never/current smoker)</th>
<th>RR (99%CI)</th>
<th>Men (Never/current smoker)</th>
<th>RR (99%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung cancer</td>
<td>61/267</td>
<td>17.8 (11.4-27.8)</td>
<td>44/348</td>
<td>14.6 (9.1-23.4)</td>
</tr>
<tr>
<td>All cancer</td>
<td>605/525</td>
<td>3.2 (2.6-3.9)</td>
<td>324/665</td>
<td>3.8 (3.1-4.8)</td>
</tr>
<tr>
<td>Vascular</td>
<td>784/476</td>
<td>3.2 (2.7-3.9)</td>
<td>500/643</td>
<td>2.6 (2.1-3.2)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>119/206</td>
<td>8.5 (6.1-11.8)</td>
<td>45/188</td>
<td>9.0 (5.6-14.4)</td>
</tr>
<tr>
<td>All diseases</td>
<td>2190/1579</td>
<td>3.0 (2.7-3.3)</td>
<td>1283/2030</td>
<td>2.8 (2.4-3.1)</td>
</tr>
</tbody>
</table>

* Cox- proportional HR adjusted for age, education, alcohol, adiposity (BMI),

Source: Jha et al, NEJM , Jan 24, 2013
US Women, smoker: non-smoker risks over time

Rate per 100,000

Women

Source: Thun et al, NEJM, Jan 24, 2013
FEMALES: Survival probabilities between ages 25 and 80 years among current and never-smokers in the US

HR adjusted for age, education, alcohol, adiposity (BMI), scaled to 2004 national rates, but comparable results if only actual cohort used

Source: Jha et al, NEJM, Jan 24, 2013
MALES: Survival probabilities between ages 25 and 80 years among current and never-smokers in the US

HR adjusted for age, education, alcohol, adiposity (BMI), scaled to 2004 national rates, but comparable results if only actual cohort used

Source: Jha et al, NEJM, Jan 24, 2013
Years gained by quitting smoking by age

- 55-64: 4 years
- 45-54: 6 years
- 35-44: 9 years
- 25-34: 10 years

Source: Jha et al, NEJM, Jan 24, 2013
Reductions in risk by age stopped, UK Women (Million Women’s Study)

Source: Pirie et al, Lancet 2012
UK male cancer mortality trends at ages 35-69, 1950-2007: selected sites

Main causes of trends in recent decades

35-year risk (%)

Lung: cigarettes
Colorectal: treatment
Stomach: Unknown

Source: Peto, 2012
Canada: vascular death rates in middle age over 50 years

Male rate
7.5 / 1000
(25% dead)

Female rate
4.5 / 1000
(15% dead)

Vascular death at ages 35-69, Canada 2005:
7% Male,
3% Female
Population risk of a 35-year-old dying at ages 35–69 from smoking (shaded) or from any cause (shaded and white) *e.g., at year 2010 male death rates, out of 100 men aged 35, 19 would die before age 70 (with 4 of these deaths attributed to smoking)

<table>
<thead>
<tr>
<th>Year</th>
<th>Smoking (shaded)</th>
<th>Any Cause (shaded and white)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>19</td>
<td>42%</td>
</tr>
<tr>
<td>1970</td>
<td>19</td>
<td>41%</td>
</tr>
<tr>
<td>1980</td>
<td>15</td>
<td>37%</td>
</tr>
<tr>
<td>1990</td>
<td>11</td>
<td>31%</td>
</tr>
<tr>
<td>2000</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>2010*</td>
<td>4*</td>
<td>19%*</td>
</tr>
</tbody>
</table>

Note: Most of those killed by smoking would otherwise have survived beyond age 70, but a minority (shaded area to right of dotted line) would have died by 70 anyway.
Population risk of a 35-year-old dying at ages 35–69 from smoking (shaded) or from any cause (shaded and white)

*eg, at year 2010 female death rates, out of 100 women aged 35, 13 would die before age 70 (with 3 of these deaths attributed to smoking)

**FEMALE**

<table>
<thead>
<tr>
<th>Year</th>
<th>Risk</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>2.0</td>
<td>25%</td>
</tr>
<tr>
<td>1970</td>
<td>3.5</td>
<td>24%</td>
</tr>
<tr>
<td>1980</td>
<td>4.7</td>
<td>22%</td>
</tr>
<tr>
<td>1990</td>
<td>4.8</td>
<td>20%</td>
</tr>
<tr>
<td>2000</td>
<td>3.4</td>
<td>16%</td>
</tr>
<tr>
<td>2010</td>
<td>2.9*</td>
<td>13%*</td>
</tr>
</tbody>
</table>

**Note:** Most of those killed by smoking would otherwise have survived beyond age 70, but a minority (shaded area to right of dotted line) would have died by 70 anyway
Chinese cigarette increase 40 years after US increase

Delayed hazard: observed (1950, 1990) and predicted (2030) proportions of all deaths at ages 35-69 due to tobacco

<table>
<thead>
<tr>
<th></th>
<th>US (all adults)</th>
<th>China (men)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>1990</td>
<td>33%</td>
<td>2030</td>
</tr>
<tr>
<td>1990</td>
<td>33%</td>
<td>2030</td>
</tr>
</tbody>
</table>

Source: Peto et al, Nature Medicine, 2001
### China: Proportion of deaths among middle-aged males from smoking

<table>
<thead>
<tr>
<th>Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990s</td>
<td>12%</td>
</tr>
<tr>
<td>2010 *</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>(25% urban, 15% rural)</td>
</tr>
<tr>
<td>1998 Hong Kong +</td>
<td>33%</td>
</tr>
<tr>
<td>2030s China</td>
<td>33%</td>
</tr>
</tbody>
</table>

* Zhengming Chen, personal communication
+ Hong Kong male smokers started smoking seriously 20 years before

Annual Chinese cigarette production, 1952-2011

Yang G Tob Control 2014;23:167-172
GATS+US+UK:  16 countries, 4B population, 2.3B age <35

Of 2.3B age <35, 0.5B either smoke, or will smoke by age 30 (at current 25-34 prevalences): 450M male, 50M female.

If 500M smoke at 30 (mostly starting before age 20) ~250M will eventually be killed by it, unless they quit.

If they don’t start, or stop before age 40 (preferably well before 40), >90% of these tobacco deaths will be avoided
INDIA: 1 million tobacco deaths per year during the 2010s

Jha et al, NEJM 2008
INDIA: Years of life lost among 30 year old smokers* (MDS results)

<table>
<thead>
<tr>
<th>Smoking Habit</th>
<th>Years Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men who smoke bidis</td>
<td>6 years</td>
</tr>
<tr>
<td>Women who smoke bidis</td>
<td>8 years</td>
</tr>
<tr>
<td>Men who smoke cigarettes</td>
<td>10 years</td>
</tr>
</tbody>
</table>

* At current risks of death versus non-smokers, adjusted for age, alcohol use and education (note that currently, few females smoke cigarettes)

Source: Jha et al, NEJM, Feb 2009
Cigarettes displacing bidis: men aged 15-69 yrs from 1999 to 2009/10

Source: CGHR, in press
Any smoking kills

Risk of death by amount and type, men aged 30-69: smoker vs. nonsmoker risk ratio

<table>
<thead>
<tr>
<th>Bidi (no./day)</th>
<th>Ratio</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td></td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-14</td>
<td></td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15+</td>
<td></td>
<td></td>
<td>2.2</td>
<td></td>
</tr>
</tbody>
</table>

Not caused by smoking

<table>
<thead>
<tr>
<th>Cigarette (no./day)</th>
<th>Ratio</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td></td>
<td>1.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8+</td>
<td></td>
<td></td>
<td>2.9</td>
<td></td>
</tr>
</tbody>
</table>

Excess risk from smoking

*adjusted for age, alcohol use and education
Smoking population

- Smoking population, ages 15-69 years (Millions)

<table>
<thead>
<tr>
<th>Gender</th>
<th>1998</th>
<th>2009/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both</td>
<td>88</td>
<td>115</td>
</tr>
<tr>
<td>Men</td>
<td>83</td>
<td>105</td>
</tr>
<tr>
<td>Rural men</td>
<td>62</td>
<td>77</td>
</tr>
<tr>
<td>Urban men</td>
<td>20</td>
<td>28</td>
</tr>
</tbody>
</table>

Source: CGHR, in press
## Deaths from smoking in year 2010 in Bangladesh, ages 25-69, by disease

<table>
<thead>
<tr>
<th>Disease</th>
<th>Total deaths</th>
<th>Not due to smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer</td>
<td>31,500</td>
<td>12,000 39%</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>5,400</td>
<td>2,100 39%</td>
</tr>
<tr>
<td>Other respiratory</td>
<td>9,500</td>
<td>1,000 11%</td>
</tr>
<tr>
<td>Vascular</td>
<td>71,400</td>
<td>21,600 30%</td>
</tr>
<tr>
<td>Injury</td>
<td>3,600</td>
<td>0 -</td>
</tr>
<tr>
<td>Other (non-tobacco)</td>
<td>19,400</td>
<td>0 -</td>
</tr>
<tr>
<td><strong>TOTAL, ALL DISEASES</strong></td>
<td><strong>172,000</strong></td>
<td><strong>44,800 26%</strong></td>
</tr>
</tbody>
</table>

Source: Alam et al, 2012
Cumulative risk of death, Bangladeshi men age 25-69, smokers vs. nonsmokers

*adjusted for age, alcohol use and education

Source: Alam et al, 2013
## Deaths from smoking in rural South African men, ages 25-69, by disease ~2000

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Study #</th>
<th>Smokers in the study (%)</th>
<th>OR* (95% CI)</th>
<th>Smoking associated excess deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuberculosis</td>
<td>397</td>
<td>191 (48%)</td>
<td>1.5 (1.1 - 2.2)</td>
<td>67</td>
</tr>
<tr>
<td>Cancer</td>
<td>121</td>
<td>55 (45%)</td>
<td>1.6 (0.9 - 2.9)</td>
<td>21</td>
</tr>
<tr>
<td>All CVD</td>
<td>265</td>
<td>92 (35%)</td>
<td>1.2 (0.7 - 2.0)</td>
<td>17</td>
</tr>
<tr>
<td>Respiratory</td>
<td>84</td>
<td>39 (46%)</td>
<td>1.6 (0.9 - 2.8)</td>
<td>14</td>
</tr>
<tr>
<td>All other medical</td>
<td>744</td>
<td>307 (41%)</td>
<td>1.4 (1.0 - 1.9)</td>
<td>80</td>
</tr>
<tr>
<td><strong>Sub total:</strong></td>
<td><strong>1611</strong></td>
<td><strong>684 (42%)</strong></td>
<td><strong>1.4 (1.0 - 1.9)</strong></td>
<td><strong>217</strong></td>
</tr>
</tbody>
</table>

SUGGESTS 12% of male deaths due to smoking

*adjusted for age, alcohol use and education

Source: CGHR unpublished
Current mortality risks for smokers vs never; Males

UK/US/Japan
India-cig
Hong Kong males
South Africa-Coloureds
Agincourt-Black
South Africa-White
South Africa-Black


RELATIVE RISKS
DARK BAR=NOT CAUSED BY SMOKING
GATS1 (orange) in 14 countries, B,R,I,C, + 10 other LMICs

GATS+US+UK: 16 countries, 4B population, 2.3B age <35

Of 2.3B age<35, 0.5B either smoke, or will smoke by age 30
(at current 25-34 prevalences): 450M male, 50M female.
Leading cancers in men and women, age 30-69 years

MEN
• Oral 45,800 or 23%
• Stomach 25,200 or 13%
• Lung 22,900 or 11%

WOMEN
• Cervical 33,400 or 17%
• Stomach 27,500 or 14%
• Breast 19,900 or 10%

Source: Dikshit et al, Lancet 2012
### Attributable fractions and totals for oral cancer deaths ages 30-69, 2005 India

<table>
<thead>
<tr>
<th></th>
<th>Males /000’s</th>
<th>Female /000’s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smoking</strong></td>
<td>33% / 15</td>
<td>4% / 0.8</td>
</tr>
<tr>
<td><strong>Chewing</strong></td>
<td>14% / 6.5</td>
<td>34% / 6.5</td>
</tr>
<tr>
<td><strong>Drinking</strong></td>
<td>23% / 10.4</td>
<td>4% / 0.7</td>
</tr>
</tbody>
</table>

Source: Patra et al, Br J Cancer
<table>
<thead>
<tr>
<th>Type</th>
<th>Hindu</th>
<th>Muslim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical</td>
<td>1.06</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>(340)</td>
<td>(24)</td>
</tr>
<tr>
<td>Oral</td>
<td>1.01</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>(190)</td>
<td>(24)</td>
</tr>
<tr>
<td>Breast</td>
<td>0.92</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>(178)</td>
<td>(32)</td>
</tr>
</tbody>
</table>

Source: Dikshit et al, Lancet 2012
Summary odds ratio (OR) of 13 studies of non-fatal oral cancer in India 1990 onward random effects model

<table>
<thead>
<tr>
<th></th>
<th>Males (95%CI)</th>
<th>Females (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>1.66 (1.25-2.21)</td>
<td>2.56 (1.84-3.56)</td>
</tr>
<tr>
<td>Chewing</td>
<td>4.46 (2.71-7.35)</td>
<td>10.83 (5.97-19.64)</td>
</tr>
</tbody>
</table>

Source: Singhal et al, Lancet 2012
Cervical cancer rates by state, women 30-69 years

Age-standardized mortality rates per 100,000

Jammu & Kashmir: 2.3
Assam: 3.5
India: 16

Source: Dikshit et al, Lancet 2012
Which interventions help current smokers to quit?

• Higher cigarette/bidi taxes: 50% higher price means 10% of CURRENT SMOKERS WILL QUIT
  – Greater effects on the poor and in youth

• Non-price measures: big, local packet warnings labels with tax stamp (to counter smuggling), absolute ad and promo ban, complete ban on public smoking, monitor and report smoking mortality, counter smuggling

• Increased access to nicotine replacement and other cessation therapies

Source: Jha et al, 2013, DCP3
Price elasticity in humans (cigarettes, age 15+)

10% higher price
= 2-4% current smokers quit
= 2-4% kids don’t start

Source: Chaloupka et al, 2008
Price elasticity in monkeys (various addictive goods)

Source: Hursh and Winger, 1995
Cigarette prices tripled, smoking halved, revenue doubled: FRANCE and SOUTH AFRICA
Cigarette prices tripled, consumption halved, tax revenue doubled: FRANCE
Cigarette prices tripled, consumption halved, tax revenue doubled: SOUTH AFRICA
UK & France, lung cancer mortality trends (35-44) to 1997, but not beyond

UNITED KINGDOM
Lung cancer mortality at ages 35–44

FRANCE
Lung cancer mortality at ages 35–44

*Mean of annual rates in the two component 5–year age groups
Source: WHO mortality & UN population estimates
UNITED KINGDOM 1950–2009: Males & Females
Lung cancer mortality at ages 35–44

FRANCE 1950–2007: Males & Females
Lung cancer mortality at ages 35–44

*Mean of annual rates in the two component 5-year age groups
Source: WHO mortality & UN population estimates

Source: Peto, 2012
Tax structure: importance of excise tax

• Analyses of EU 1998-2007
• Greater reliance on specific tobacco excises will:
  – Reduce gap in prices between high and low priced cigarette brands (ad valorem increases gap)
  – Produce more stable, predictable stream of cigarette excise tax revenues
  – Have greater impact on cigarette smoking
• Mexico’s structure (oligopoly with Phillip Morris and BAT) works in favour of higher excise
• Maximal health and revenue impact involves specific taxes, regularly adjusted for inflation, comparable on all tobacco products and complementary policies to reduce industry price manipulation

Excise taxes underused in LMICs
Objections to higher tobacco taxes

- **Job losses:** In most economies, no net impact (money not spent on tobacco is spent on other goods and services)

- **Revenue loss:** “Laffer curve”- revenue declines not seen in practice nearly anywhere

- **Hurts the poor:** poor more price responsive, and gain more of the health benefits than the rich

- **Smuggling:** legitimate concern but consumption falls, revenue increases even with smuggling, and can counter with labels with tax stamp, smart labels, and coordination
Social inequalities in male mortality in 1996 from smoking (shaded) and any cause

Source: Jha et al, Lancet, July 2006
Over 1.3 million (M) quitters in Canada, 1999-2009 age 15+

<table>
<thead>
<tr>
<th>Year</th>
<th>Ex-smoker</th>
<th>Current</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>6.1 M (50%)</td>
<td>6.1 M (50%)</td>
<td>11.9 M (49%)</td>
</tr>
<tr>
<td>2009</td>
<td>7.4 M (60%)</td>
<td>4.9 M (40%)</td>
<td>15.4 M (56%)</td>
</tr>
</tbody>
</table>

Source: Jha et al, forthcoming
Tobacco deaths in Canadian men by income (% of total)

Source: Jha et al, CMAJ in press
**People’s Republic of China**
Distribution of marginal taxes and health benefits by SES group

**Marginal taxes paid by SES**
- Low SES: 6.4%
- Middle SES: 53.2%
- High SES: 40.4%

**Deaths averted by SES**
- Low SES: 19.0%
- Middle SES: 48.9%
- High SES: 32.1%

**Low SES group:**
Pays 6.4% of increased taxes but receives 32.1% of health benefits: hence, health/tax ratio: **5.02**

% of income: Net gain for lowest 2 quintiles, net loss for highest 3 quintiles

Source: ADB 2013, Verguet 2013
Mexico: 7 peso (25%) tax rise, 2010

GOAL: 10 peso hike

- Good epidemiologic analyses
  - Mexico: ~11 M smokers so 4-6 M will die from smoking unless they quit
  - Price elasticities and poverty analyses
  - Immediate follow up numbers to show increasing revenue, decreasing consumption, no major smuggling

- International seminar with MoF:
  - Political visibility
    - Senator Saro
    - Organized NGO protests on steps of MoF
    - Slogan: 10 pesos for 1 million lives saved

- Linked to financing development:
  - “soft earmarking” - more money focused on poverty reduction
Plain packaging (Australia) and pictorial warning labels (Canada)
Combating illicit trade

- A 10% increase in law enforcement –assuming no change in income, will
  - Decrease smuggling activities by 5.4%
  - Reduce global consumption by 2.3%
  - Increase governments’ tax revenues by 7.8% despite 4% total tax revenue lost due to smuggling

- **Lessons from Spain** which reduced share of smuggled cigarettes from estimated 15% in 1995 to 5% in 1999
  - Focus on large scale, container smuggling
  - Strengthened tax administration with new technology and better enforcement
  - Collaboration with France, Andorra, Ireland, UK and the EU Anti-Fraud Office
  - Did NOT focus on individual tax avoidance, street sellers

- **Lessons from California:** high tech approaches

Source: Yarely & Sayings 2006, Yurekil, 201
Canada Sharply Reduced Taxes in 1993

Real price per pack (USD)

Tax reduced in an attempt to counter smuggling

Real Price

Consumption

Over 1.3 million (M) quitters in Canada, 1999-2009 age 15+

<table>
<thead>
<tr>
<th>Year</th>
<th>Ex-smoker</th>
<th>Current</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>6.1 M (50%)</td>
<td>6.1 M (50%)</td>
<td>11.9 M (49%)</td>
</tr>
<tr>
<td>2009</td>
<td>7.4 M (60%)</td>
<td>4.9 M (40%)</td>
<td>15.4 M (56%)</td>
</tr>
</tbody>
</table>

Source: Jha et al, forthcoming
National: Epi + economic evidence to raise tax
Local: Randomize politicians to enforce laws

DESH Random intervention:
Local information to leaders on (A) general health; (B) tobacco

Target: MPs, MLAs, doctors, health workers and technocrats in 600 districts

<table>
<thead>
<tr>
<th>A</th>
<th>No A</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>150</td>
</tr>
<tr>
<td>No B</td>
<td>150</td>
</tr>
</tbody>
</table>

Outcome:
Quit rates
Service use & healthcare spending
Marginal costs for maximal child survival are falling

“Critical” incomes is real $ needed to achieve ½ of maximal survival (in that year) from 1970 to 2007

Source: Hum et al, eLife 2012
Marginal costs for maximal adult survival are rising

"Critical" incomes is real $ needed to achieve ½ of maximal survival (in that year) from 1970 to 2007; note higher adult costs due in part to HIV and tobacco

Source: Hum et al, eLife 2012
Million Death Study Collaborators

**Indian Academic Partners (in alphabetical order):**

Clinical Epidemiology Resource and Training Centre Trivandrum: KB Leena, KT Shenoy (until 2005)
Department of Community Medicine Gujarat Medical College Ahmedabad: DV Bala, P Seth KN Trivedi
Department of Community Medicine Kolkata Medical College Kolkata: SK Roy
Department of Community Medicine Regional Institute of Medical Sciences Imphal: L Usharani
Department of Community Medicine S.C.B. Medical College Cuttack Orissa: Dr. B Mohapatra
Department of Community Medicine SMS Medical College Jaipur: AK Bharadwaj, R Gupta
Epidemiological Research Center Chennai: V Gajalakshmi, CV Kanimozhi
Gandhi Medical College Bhopal: RP Dikshit, S Sorangi
Healis-Seskarhia Institute of Public Health Mumbai: PC Gupta, MS Pednekar, S Sreevidya
Indian Institute of Health & Family Welfare, Hyderabad: P Bhatia
Institute of Health Systems Research Hyderabad: P Mahapatra (until 2004)
St. John’s Research Institute St. John’s Academy of Health Sciences Bangalore: A Kurpad, P Mony, M Vaz, R Jotkar, S Rao-Seshadri, S Shrihari, S Srinivasan
King George Medical College Lucknow: S Awasthi
Najafgarh Rural Health Training Centre Ministry of Health Government of India New Delhi: N Dhingra, J Sudhir, I Rawat (until 2007)
National Institute of Mental Health and Neurosciences Bangalore: G Gururaj (until 2004)
North Eastern Indira Gandhi Institute of Regional Medical Sciences Shillong Meghalaya: FU Ahmed (until 2005), DK Parida
Regional Medical Research Center ICMR Institute Bhubaneshwar: AS Karketta, SK Dar
School of Preventative Oncology Patna: DN Sinha
School of Public Health Post Graduate Institute of Medical Education and Research Chandigarh: N Kaur, R Kumar, JS Thakur
Tata Memorial Hospital Mumbai: RA Badwe, RP Dikshit, K Mohandas

**Lead Partners:**

Office of the Registrar-General India RK Puram New Delhi India: C Chandramouli (Registrar General of India [RGI]), RC Sethi, B Mishra, S Jain (until 2008), DK Dey (until 2009), AK Saxena, MS Thapa, N Kumar, JK Banthia and DK Sikri (former RGIs)
Million Death Study Coordinating Centre for Global Health Research (CGHR) Li Ka Shing Knowledge Institute Keenan Research Centre St. Michael’s Hospital Dalla Lana School of Public Health University of Toronto Canada: DG Bassani, P Jha (Principal Investigator), R Jotkar, R Kamadod, B Pezzack, S Rao-Seshadri, P Rodriguez, J Sudhir, C Ramasundarahettige, W Suraweera

**Affiliated Partners:**

Indian Council of Medical Research New Delhi India: VM Katoch (Director General or DG from 2008), NK Ganguly (DG to 2008), L Kant, B Bhattacharya
School of Population Health The University of Queensland Australia: AD Lopez, C Rao
World Health Organisation Geneva and SEARO Office New Delhi: T Boerma, T Evans, A Fric, S Habayeb (former WHO Representative-India), S Khanum, C Mathers, DN Sinha, N Singh, P Singh (Deputy Regional Director)
Clinical Trial Service Unit and Epidemiological Studies Unit (CTSU) University of Oxford England: N Bhala, J Boreham, Z Chen, R Collins, R Peto, G Whitlock
CONCLUSIONS:

- On current patterns: 1 Billion smoking deaths this century, including about 250 million deaths among those <35 years in just 16 countries
- Prolonged smokers lose about one decade of life
- Cessation by age 40 (and preferably earlier) avoids 90% of the excess risk of continued smoking
- WHO goal of 30% reduction in smoking can be achieved by tripling the excise tax worldwide
- Mortality monitoring is needed: various strategies possible at low cost, high-impact

Source: Jha and Peto, NEJM, 2014
CONCLUSIONS: Monitoring the tobacco epidemic

• Prospective studies, with good control for prolonged smoking, and reverse causality ("cancer cures smoking")
• Retrospective case control studies using living controls (e.g. India Million Death Study)
• Retrospective proportional mortality using non-tobacco attributable deaths (China, South Africa, Bangladesh): Smoking on death certificates
• Indirect methods-Peto method indexing on lung cancer
www.cghr.org/tobacco

(Don’t buy my books)
“And it was so typically brilliant of you to have invited an epidemiologist.”